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10/500,079	03/01/2005	Jochen Kraft	14603-007US1	5865

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EXAMINER	
MAI, ANH D	

ART UNIT	PAPER NUMBER
2814	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/500,079	KRAFT ET AL.	
	Examiner	Art Unit	
	Anh D. Mai	2814	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *14 June 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-5 and 7-28* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-5 and 7-28* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Status of the Claims

1. Amendment filed June 14, 2007 is acknowledged. Claims 1, 13, 19 and 20 have been amended. Claims 6 and 9 have been cancelled. Claims 21-28 have been added. Claims 1-5, 7, 8 and 10-28 are pending.

Specification

2. The Amendment to the Specification filed June 14, 2007 is acknowledged.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 27 and 28 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

There does not appear to be a written description of the claim limitation "wherein a PN junction generated by counter-doping with the pentavalent substance is in **about a middle of the second doping laver**" (claim 27 and 28) in the application as filed.

4. Claims 1-5 and 7-28 rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

In response to the rejections under 101 and 112 in the previous Office Action, Applicant explicitly state that the doping of the layers existed as a device, not during the operation.

Therefore, the specification is lacking enablement because: in a counter-doping, it is well known in the art that the dopant of one doping type would have neutralized the other doping type.

In this case, the counter doping comprises a doping concentration of E20 to E21 cm^{-3} would have completely neutralized any opposite doping concentration which is less than E20 cm^{-3}.

Therefore, by the action of the counter-doping, the claimed first and second layers ceased to exist or instead of p-type, these layers are now n-type. Since higher concentration of pentavalent substance **have neutralized** the lower concentration of trivalent substance.

Why the counter-doping of a higher concentration dopant fail to eliminate the dopant of a lower, opposing type, dopant ?

Claim Rejections - 35 USC § 102/103

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 1-5, 7-17 and 19-28 are rejected under 35 U.S.C. 102(b) as anticipated by Asai et al., (WO 01/91162) of record or, in the alternative, under 35 U.S.C. 103(a) as obvious over Asai in view of H.J. Osten et al., *The Effect of Carbon Incorporation on SiGe Heterobipolar Transistor Performance and Process Margin,* IEDM 1997, pp. 803-806, of record.

With respect to claim 1, as best understood by the examiner, Asai teaches a transistor as claimed including:

an emitter region (129);

a collector (102); and

a base layer (111 or 211) having a base contact (115), the base layer (111 or 211) comprising:

an intrinsic region (119) between the emitter (129) and the collector (102);

an extrinsic region (116) between the intrinsic region (119) and a the base contact (115); and

a first doping layer (153-top) that is doped with a trivalent (boron) doping substance, that extends into the extrinsic region (116) and that is counter-doped with a pentavalent (phosphorous) substance from the emitter region (129);

wherein the base layer (111 or 211) comprises carbon atoms having a concentration greater than $1x10^{18}$ cm^{-3}. (See Figs. 1-2 and 13).

Although Asai does not explicitly specify the concentration of carbon atoms (in term of #atoms per cm^3) in the base layer (111 or 211), however, Asai clearly teaches the base layer (211) includes: $Si_{1-x}Ge_xC_y$ ($0\leq x, y<1$) or $Si_{1-y}C_y$ ($0\leq y<1$).

It is well known that, there are $5x10^{22}$ Si atoms/cm^3 in single crystal silicon. The claimed concentration value of $1x10^{18}$ carbon atoms cm^{-3} (which is **significantly less** than the impurity, arsenic doping level, i.e., E20 to E21), is four order of magnitude less than E22 or >1/10,000 (E22 – E18). By indicating the amount of ($0\leq x, y<1$) or ($0\leq y<1$), Asai implicitly indicated that carbon atoms within the layer 211 is **significant more** than 1/10,000 or greater than $1x10^{18}$ atoms cm^{-3}.

Note that the specification contains no disclosure of either the *critical nature of the claimed carbon concentration of greater than E18 atoms cm^{-3}* of any unexpected results arising therefrom. Where patentability is aid to based upon particular chosen dimension or upon another variable recited in a claim, the Applicant must show that the chosen dimension are critical. *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Alternatively, Asai clearly teaches the base layer (211) further comprises carbon, $Si_{1-x}Ge_xC_y$ ($0\leq x, y<1$) or $Si_{1-y}C_y$ ($0\leq y<1$), although a specific concentration is not disclosed.

However, Osten teaches that it is well known in the art that a low carbon concentration (< 10^{20} cm^{-3}) in the base layer of the HBTs can significantly suppress transient enhanced diffusion (TED) of boron.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention was made to form the base layer of Asai having the carbon concentration as taught by Osten to suppress transient enhanced diffusion (TED) of boron.

With respect to claims 2 and 10, the trivalent doping substance of Asai is comprises boron.

With respect to claim 3, the base layer (111 or 211) of Asai further comprises:

a second doping laver (153-middle + upper portion 152) that is doped with a trivalent (boron) doping substance, and that is between the first doping layer (153-top) and the collector (102); and

a third doping layer (remaining of 152) that is doped with a trivalent (boron) substance, and that is between the second doping layer (153-middle + upper portion 152) and the collector (102);

wherein the concentration of trivalent substance in the second doping layer (153-middle + upper portion) is less than the concentration of trivalent substance in the first doping layer (153-top) and the concentration of trivalent substance in the second doping layer (153-middle + upper portion 152) is less than the concentration of trivalent substance in the third doping layer (remaining of 152). (See Fig. 2).

With respect to claims 4 and 7, the first doping layer (153-top) of Asai comprises at least 30% of the total amount of a doping substance of in the base layer (111).

With respect to claims 5 and 8, the base layer (111) of Asai further comprises: a substance diffused into the base layer (111) from a region that corresponds to the collector (129).

With respect to claim 11, the second doping layer (153-middle + upper portion 152) and the third doping layer (remaining of 152) are doped with germanium.

With respect to claim 12, the concentration of germanium in the second doping layer (153-middle + upper portion 152) and the third doping layer (remaining of 152) decreases from a high point (15%) at the collector (102) to a low point (0%) in the second layer (upper 152); and

a decrease in the concentration of germanium from the high point (15%) to the low point is substantially constant (gradual).

With respect to claim 17, the trivalent substance comprises boron.

With respect to claim 21, the base layer (111 or 211) of Asai further includes a second doping layer (153-middle + upper portion 152) and a third (remaining of 152) doping layer, the second doping layer and the third doping layer each being doped with a dopant, the first, second and the third doping layers being separated from the emitter region (129) by a potion of the base layer (111 or 211). (See Fig. 2a).

With respect to claim 22, the first doping layer of Asai includes a concentration of the trivalent substance that is between E18 and 5E20 cm^{-3}.

Within purview of one having ordinary skill in the art, it would have been obvious to determine the optimum doping concentration of the layers. See In re Aller, Lacey and Hall (10 USPQ 233-237) "It is not inventive to discover optimum or workable ranges by routine experimentation", it is obvious to try higher or lower concentrations.

Furthermore, Note that the specification contains no disclosure of either the *critical nature of the claimed doping concentration of the layers* of any unexpected results arising therefrom. Where patentability is aid to based upon particular chosen dimension or upon another variable recited in a claim, the Applicant must show that the chosen dimension are critical. *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

The above applies to all claims claiming dopant concentration.

With respect to claim 23, the base layer (111 or 211) of Asai includes a second doping layer (153-middle + upper 152) that is doped with a dopant, wherein the second doping layer comprises a concentration of the dopant that is between E18 and E19 cm^{-3}; and a third doping layer (remaining of 152), the second doping layer being between the first layer and the third doping layer.

With respect to claim 24, the base layer (111 or 211) of Asai further includes an additional doping layer that is doped with a dopant and that is adjacent the collector (102), wherein the additional doping layer comprises concentration of the dopant that is between 5E18 and E21.

With respect to claim 25, the base layer (111 or 211) of Asai further includes a second doping layer that is doped with a dopant; and a third doping layer that is doped with a dopant, the

second doping layer being between the first and the third doping layers; wherein the second doping layer has a lower concentration of dopant than both the first and third doping layers.

With respect to claim 26, the base layer (111 or 211) of Asai further includes a second doping layer that is doped with a dopant; the second doping layer being between the first and the collector (102); wherein the second doping layer is counter-doped with pentavalent substance, the pentavalent substance penetrating at least half-way through the second doping layer; and wherein the second doping layer comprises a concentration of the pentavalent substance that is between E20 to E21 cm^{-3}. (See Fig. 2a).

With respect to claim 27, the base layer (111 or 211) of Asai further includes a second doping layer that is doped with a dopant; and a third doping layer that is doped with a dopant, the second doping layer being between the first and the third doping layers; wherein the PN junction generated by counter doping with the pentavalent substance is in about a middle of the second doping layer.

With respect to claim 13, as best understood by the examiner, Asai teaches a transistor as claimed including:

a base layer (111 or 211) comprising:

a first doping layer (153-top) that is doped with a trivalent substance;

a second doping layer (153-middle + upper 152) adjacent to the first doping layer (153-top) and having a lower concentration of the trivalent substance than the first doping layer (153-top); and

a third doping layer (remaining of 152) adjacent to the second doping layer (153-middle + upper 152) and having a higher concentration of the trivalent substance than the second doping layer (153-middle + upper 152);

wherein the first doping layer (153-top) and the second doping layer (153-middle + upper 152) are counter-doped with a pentavalent substance in an emitter region (129) of the transistor; and

wherein the base layer (111 or 211) comprises carbon atoms having a concentration greater than $1x10^{18}$ cm^{-3}. (See Figs. 1-2 and 13).

For discussion regarding carbon concentration, see claim 1 above.

With respect to claim 14, the second doping layer (153-middle +upper 152) and the third doping layer (remaining 152) are doped with germanium.

With respect to claim 15, the concentration of germanium in the second doping layer (153-middle +upper 152) and the third doping layer (remaining 152) decreases from a high point (15%) at a collector region (102) of the transistor to a low point (0%) in the second layer (153-middle +upper 152).

With respect to claim 16, a decrease in the concentration of germanium from the high point (15%) to the low point (0%) is substantially constant.

With respect to claim 19, as best understood by the examiner, Asai teaches a transistor as claimed including:

a collector (102);

an emitter region (129); and

a base layer (111 or 211) between the collector (102) and the emitter region (129), the base layer comprises:

an intrinsic region (119) between the collector (102) and the emitter region (129); and

an extrinsic region (116) outside the intrinsic region (119);

wherein the intrinsic region (119) and the extrinsic region (116) comprise plural layers that are doped with different concentrations of a trivalent substance;

wherein at least some of the plural layers in the intrinsic region (119) are doped, from the emitter region (129), with a pentavalent substance; and

wherein the base layer (111 or 211) comprises carbon atoms having a concentration greater than $1x10^{18}$ cm^{-3}. (See Figs. 1-2 and 13).

For discussion regarding carbon concentration, see claim 1 above.

With respect to claim 20, at least some of the plural layers in the intrinsic region (119) are doped, from the collector (102), with germanium; a concentration of the germanium decreases from a high point (15%) at the collector (102) to a low point (0%) in one of the plural layers doped with the trivalent substance; and a decrease in the concentration of germanium from the high point to the low point is substantially linear.

With respect to claim 28, as best understood by the examiner, Asai teaches a transistor as claimed including:

an emitter region (129);

a collector (102); and

a base layer (111 or 211) having a base contact (115), the base layer (111 or 211) comprising:

an intrinsic region (119) between the emitter region (129) and the collector (102);

an extrinsic region (116) between the intrinsic region (119) and a the base contact (115); and

a first doping layer (153-top) that is doped with a trivalent (boron) substance, that extends into the extrinsic region (116) and that is counter-doped with a pentavalent (phosphorous) substance from the emitter region (129); wherein the first doping layer comprises a concentration of the trivalent substance that is between E18 and 5E20 cm^{-3};

a second doping layer (153-middle + upper 152) that is doped with the trivalent substance, that extends into the extrinsic region (116), and that is counter-doped, at least part-way through, with a pentavalent substance from the emitter region (129), wherein the second doping layer comprises a concentration of the pentavalent substance that is between E20 and E21 cm^{-3}, wherein the second doping layer comprises a concentration of the trivalent substance that is between E182 and E19 cm^{-3}, and wherein a PN junction generated by counter-doping with the pentavalent substance is in about a middle of the second doping layer; and

a third doping layer (remaining of 152) that doped with the trivalent substance, the third doping layer being adjacent to the collector (102), wherein the third doping layer comprises a concentration of the dopant of the dopant that is between 5E18 and E20 cm^{-3};

wherein the second doping layer is between the first and the third doping layers, and wherein the second doping layers has a lower concentration of the trivalent substance than both the first and third doping layers;

wherein the first, second and third doping layers are separated from the emitter region (129) by a portion of the base layer; and

wherein the base layer (111 or 211) comprises carbon atoms having a concentration greater than $1x10^{18}$ cm^{-3}. (See Figs. 1-2 and 13).

For discussion regarding carbon concentration, see claim 1 above.

6. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Asai '162 and Oster as applied to claim 11 above, and further in view of Morishita (U.S. Patent No. 5,140,400) of record.

Asai teaches a transistor as described in claim 11 above including: the first doping layer (153-top) that is doped with a trivalent substance that extends into the extrinsic region and is counter-doped with a pentavalent (N-type) substance in the region adjacent to the emitter, wherein the emitter is formed with N-type having a concentration of E20 cm^{-3}.

Thus, Asai is shown to teach all the features of the claim with the exception of explicitly disclosing the atom being used for the pentavalent (N-type) substance.

However, Morishita teaches that it is well known in the art to use phosphorous, arsenic, antimony, or the like of group V atoms for N-type substance in a transistor. (Col. 10, ll. 38-46).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention was made to counter-doped the first doping layer of Asai utilizing arsenic as atoms of pentavalent substance since it is well known in the art to use any material of group V element for N-type emitter.

Response to Arguments

7. Applicant's arguments, see the Remarks, filed June 14, 2007, with respect to the rejection under 101 and 112, second paragraph, have been fully considered and are persuasive. The rejections under 100 and 112, second paragraph of the claims has been withdrawn.

8. However, since applicant admitted that, the depletion region are existed without electric field, meaning the depletion region always exist as a device, an enabling rejection has been imposed.

9. With respect to amended claim 1, by incorporating the limitation of claims 6 or 9 into claim 1, claims 2-5, 7, 8 10-12 and 17 are now depended on claims 6 or 9 (technically).

As discussed above, although Asai does not explicitly specify the concentration of carbon atoms (in term of #atoms per cm^3) in the base layer (111 or 211), however, Asai clearly teaches the base layer (211) includes: $Si_{1-x}Ge_xC_y$ ($0 \leq x, y<1$) or $Si_{1-y}C_y$ ($0 \leq y<1$).

It is well known that, there are $5x10^{22}$ Si atoms/cm^3 in single crystal silicon. The claimed concentration value of $1x10^{18}$ carbon atoms cm^{-3} (which is **significantly less** than the impurity, arsenic doping level, i.e., E20 to E21), is four order of magnitude less than E22 or >1/10,000 (E22 – E18). By indicating the amount of ($0 \leq x, y<1$) or ($0 \leq y<1$), Asai implicitly indicated that carbon atoms within the layer 211 is **significant more** than 1/10,000 or greater than $1x10^{18}$ atoms cm^{-3}.

Furthermore, the ability of carbon in suppress transient enhanced diffusion (TED) of boron are well known in the art.

Conclusion

10. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Anh D. Mai whose telephone number is (571) 272-1710. The examiner can normally be reached on 8:00AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on (571) 272-1705. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Anh D. Mai/
Primary Examiner, Art Unit 2814